ID Control System

Cross Training

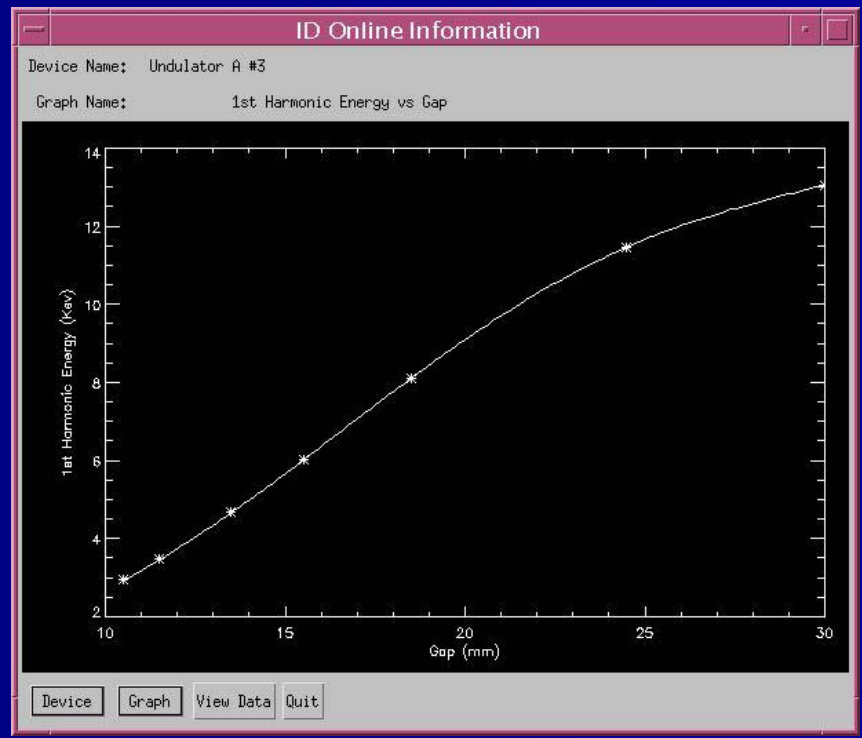
The Basics

What is an Insertion Device ?

- Insertion Device (ID):
  - A device which "inserts" a magnetic field into the particle beam path causing multiple bends in the particle beam, thus producing higher intensity X-Rays than that of a bending magnet beamline.
- Typical IDs at APS:
  - Contain an array of permanent rare earth magnets mounted on movable jaws that are able to be positioned to within about 50 microns of the storage ring vacuum chamber straight section.
  - Magnetic fields of about 1 tesla can be achieved at minimum gap.

Why Control The IDs ?

- Changing the ID gap causes changes in the magnetic field in the particle beam path thereby changing the x-ray spectrum for the beamline



Types of IDs at APS

- STI Device:
  - A 2-stepper motor ID with the top and the bottom jaws coupled together by chains and gears; built by STI Optronics.
- NGSM Device (New Gap Separation Mechanism):
  - A 4-stepper motor ID with each motor controlling each end of 2 separate jaws simultaneously.
  - Each jaw containing a magnetic array.
- Typical gap movement 11mm ~ 180mm

Types of IDs at APS (continued)

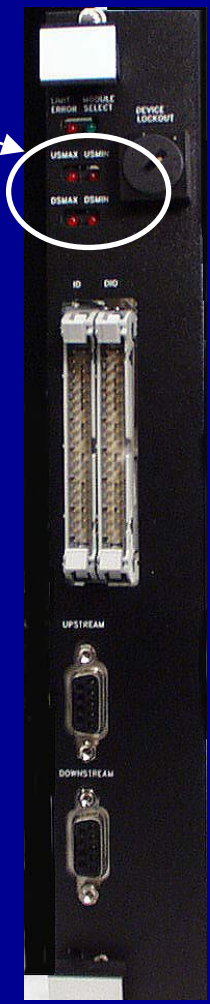
- EMW Device (Elliptical Multipole Wiggler):
  - A 2-stepper motor ID with the top and the bottom jaw being controlled separately. Permanent magnets in the vertical plane and electromagnets in the horizontal plane.
  - Normally operated at a 24mm gap (sector 11)
- CPU Device (Circularly Polarized Undulator):
  - A fixed gap ID with only electromagnets.
  - Sector 4

Installed IDs at APS

- Currently 20 2-motor (STI) devices, 7 4-motor (NGS) devices, 1 CPU device, and 1 EMW device.
- Total of 29 insertion devices located in 26 sectors around the storage ring.

ID Control System Interlocks

- Limit switch logic
  - How it works:
    - A minimum limit hit at one end stops that end from closing any further while inhibiting opening of the opposite end of the ID
    - A maximum limit hit at one end stops that end from opening any further while inhibiting closing of the opposite end of the ID
  - Prevents ID from crushing the vacuum chamber
  - "Hard wired" limit switches remove AC input power from the stepper motor drives



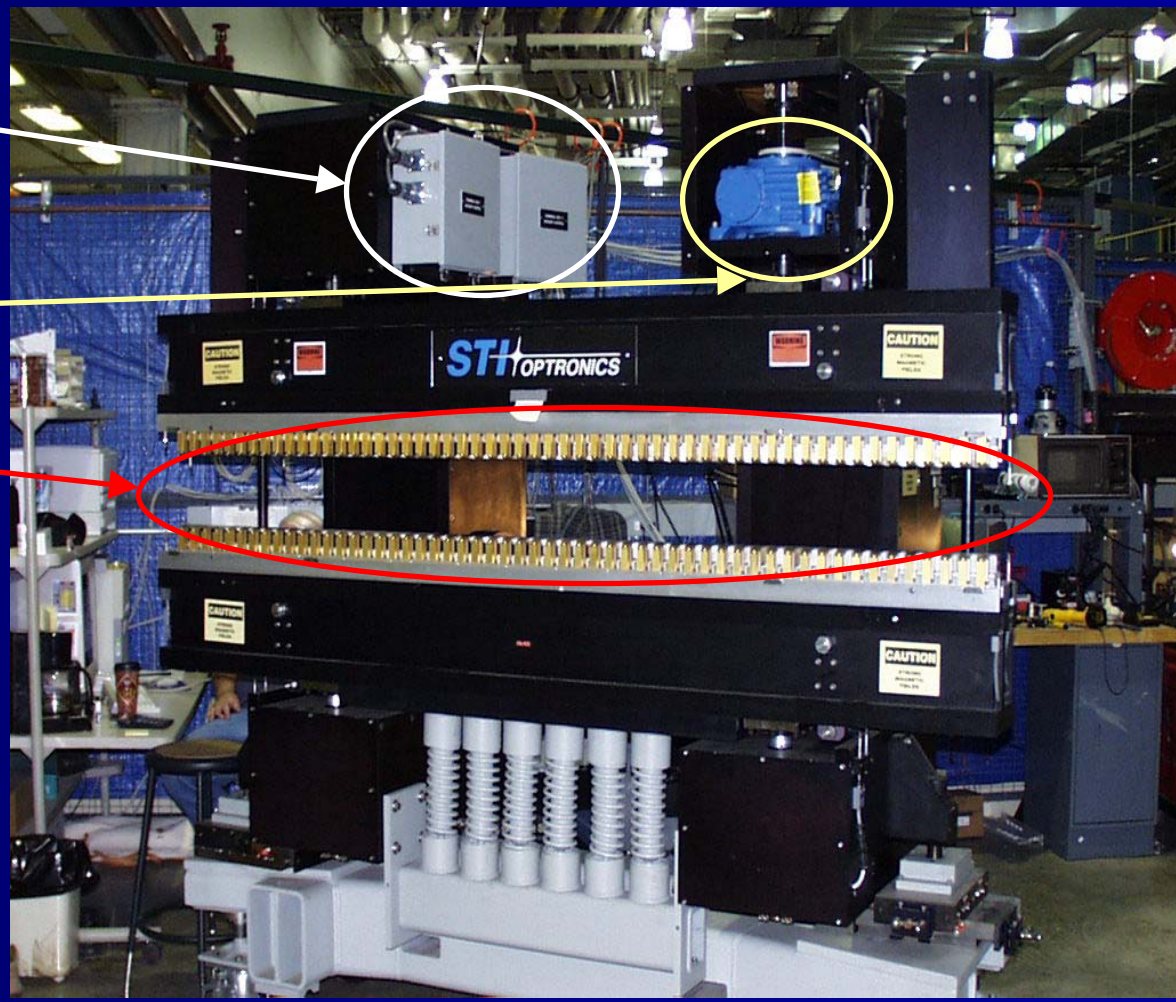
STI Insertion Device

ID wiring interface boxes

Gearbox

Magnetic array

2 motors run each end of this device

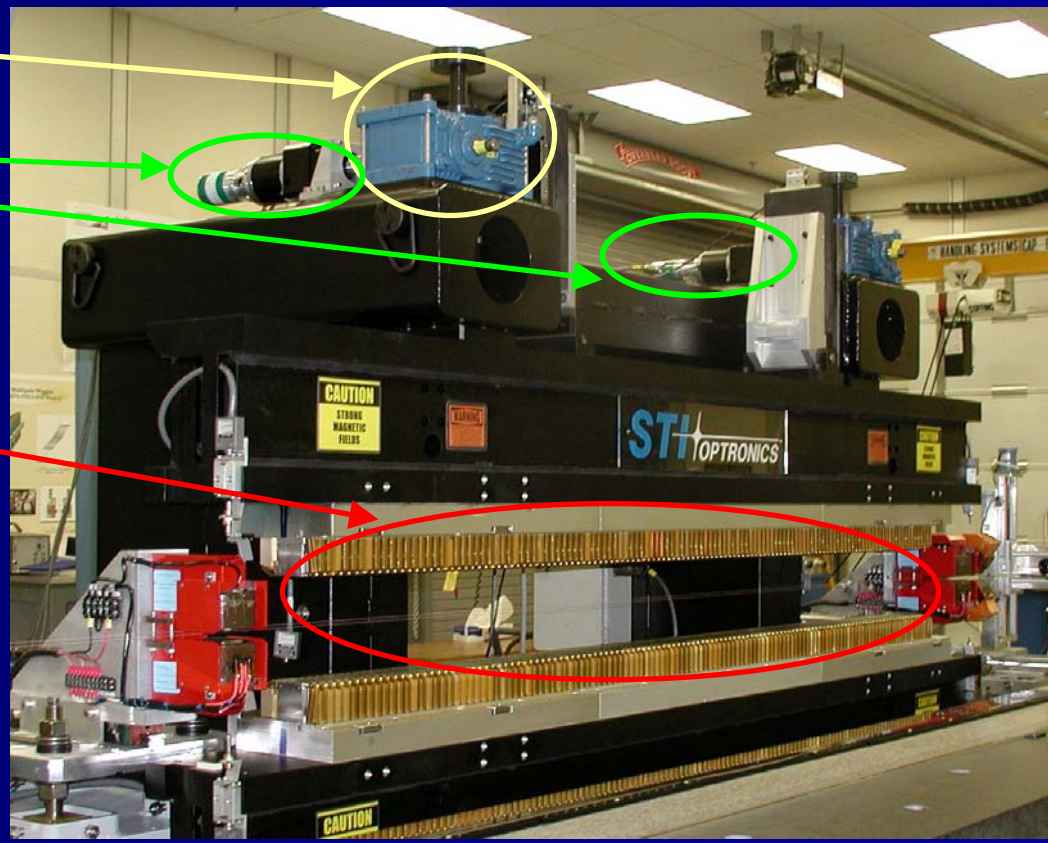


NGSM Insertion Device

Gearbox

Rotary encoder & motor assembly

Magnetic array



4 motor device:

Each stepper motor controls each end of each jaw

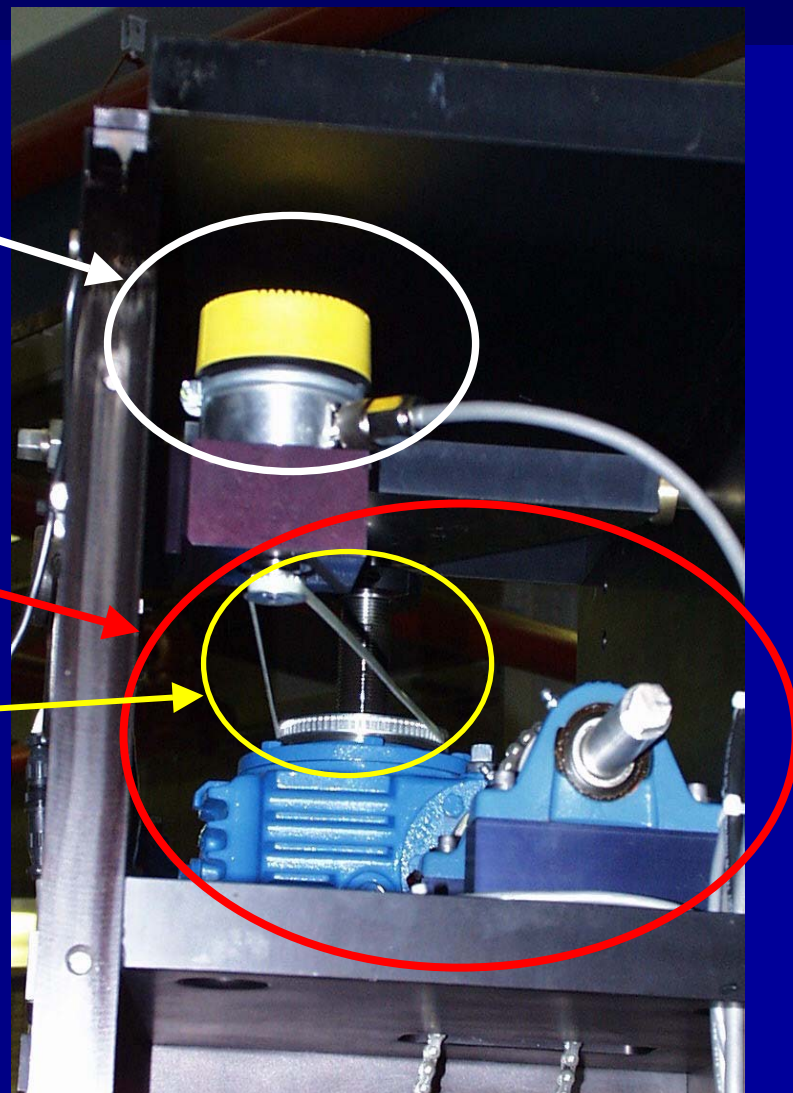
STI Insertion Device

Stegmann rotary encoder

(SSI Output)

ID jaw drive mechanism and encoder belt

Encoder drive belt



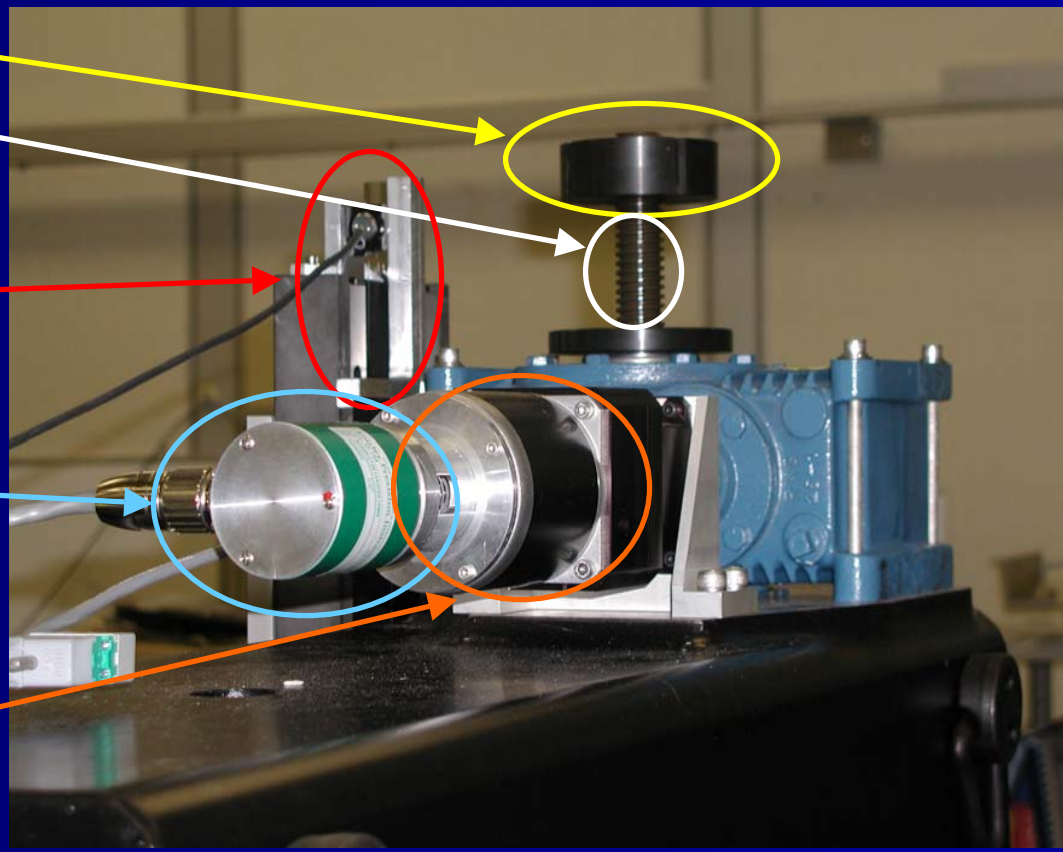
NGSM Insertion Device

Minimum gap hardstop
ID jaw drive screw

Gurley linear encoder

Gurley rotary encoder

Stepper motor



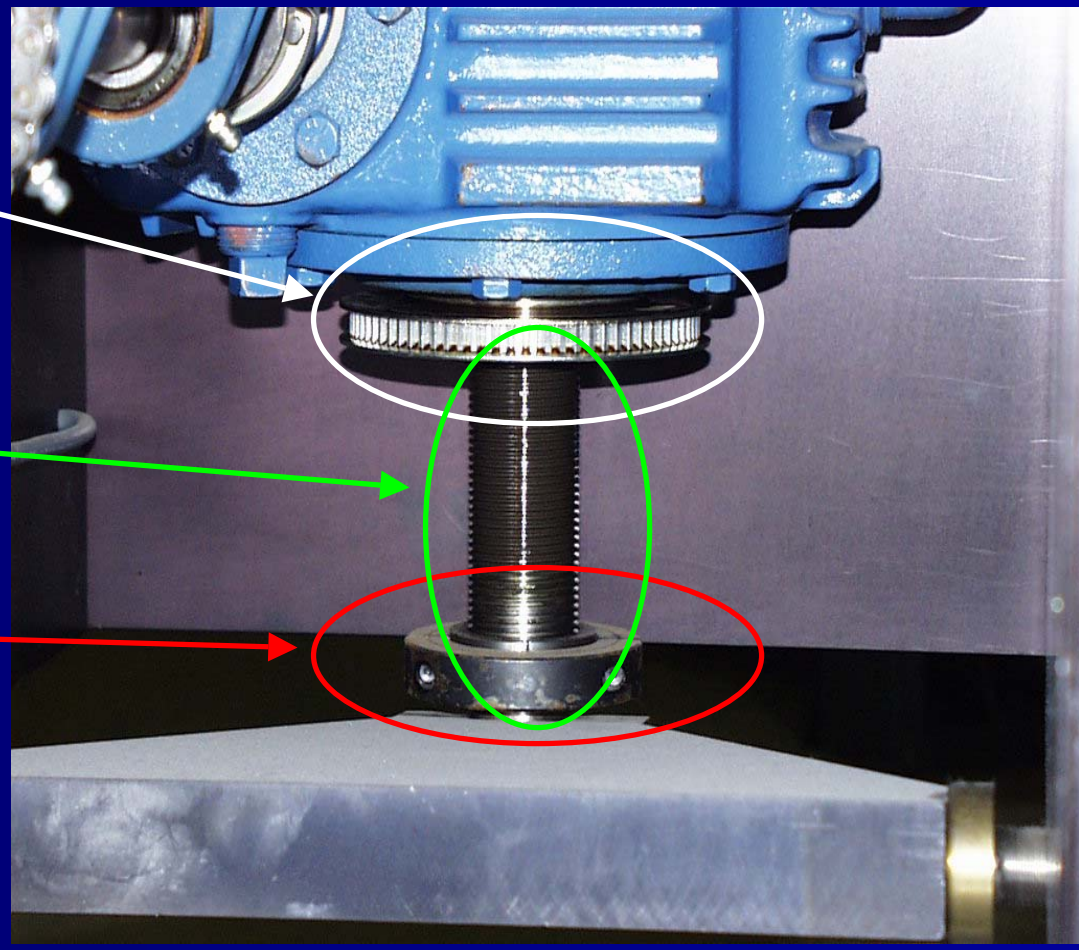
STI Insertion Device

Rotary encoder drive belt and gear:

Uses a plastic belt

ACME drive screw

ID hard stop



STI Gap Separation System

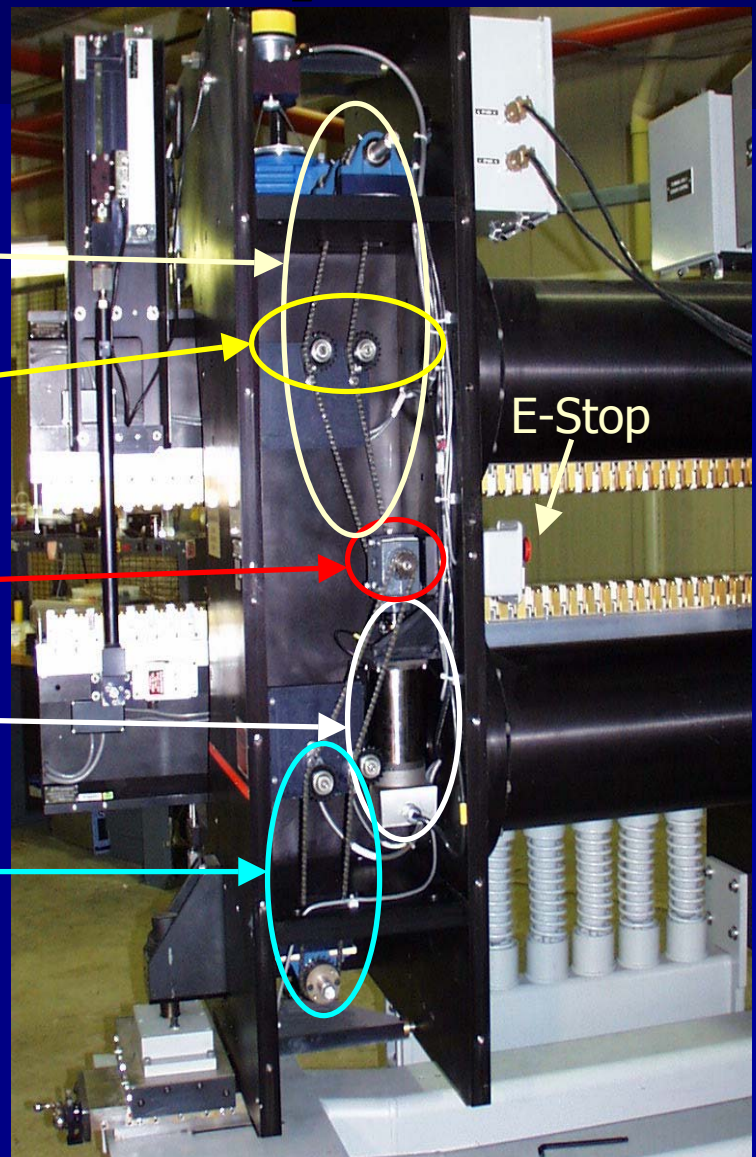
Upper jaw drive chain

Chain tension adjustment

Gearbox

Stepper Motor

Lower jaw drive chain



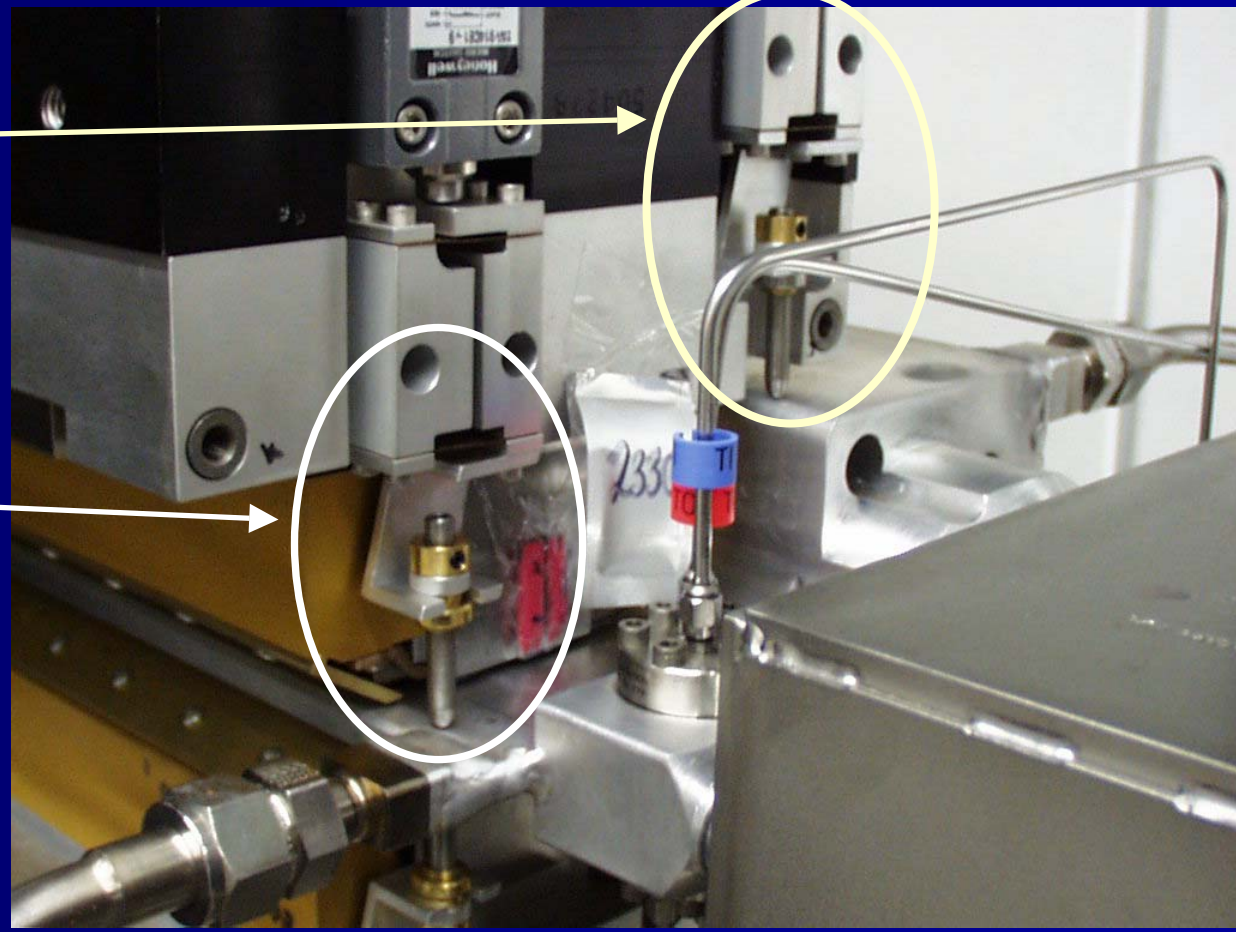
Minimum ID Limit Switches

Minimum limit switch:

Stops this end from closing

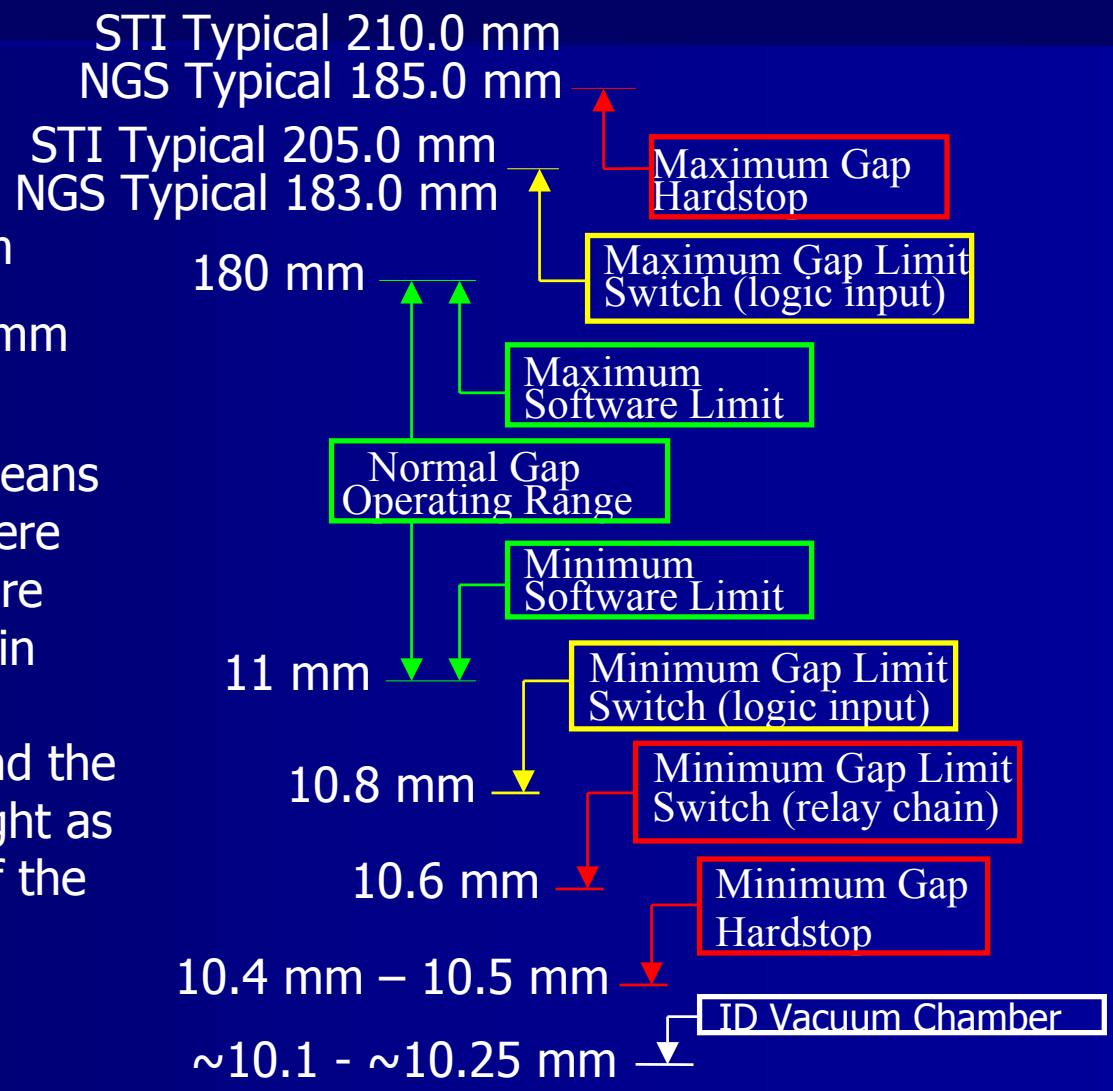
Minimum limit switch:

Shuts off AC stepper motor drive power

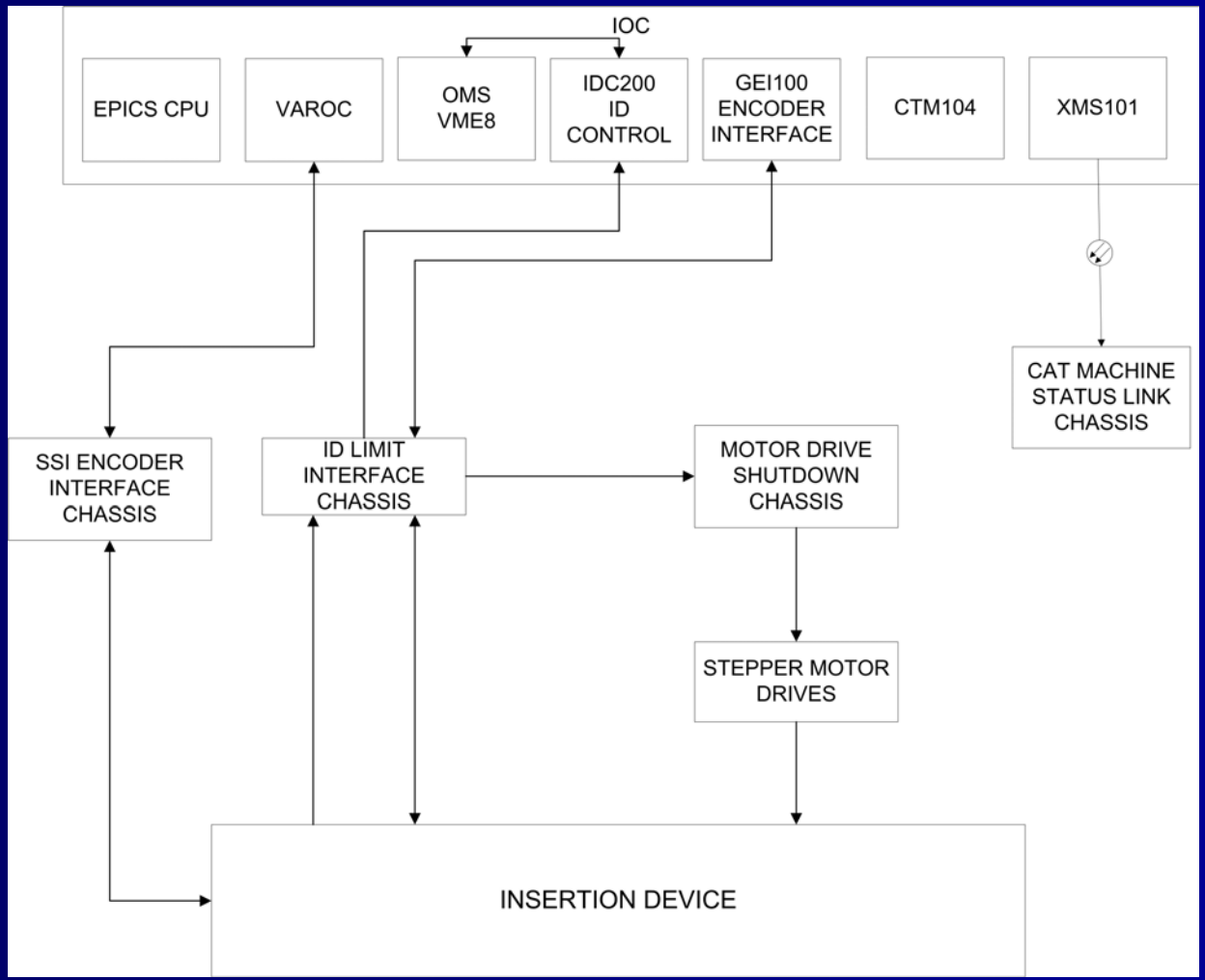


ID Safeguards & Operating Ranges

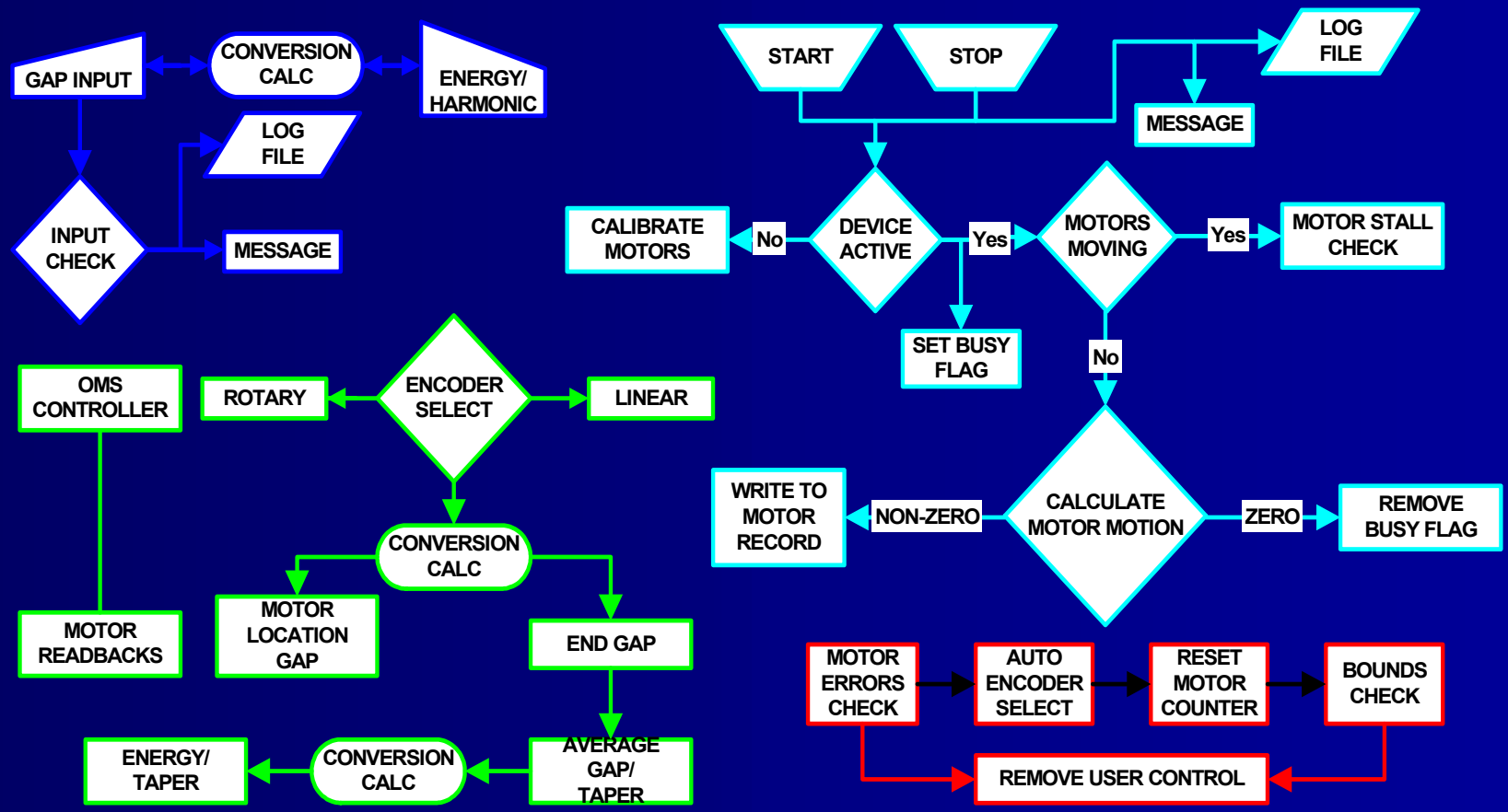
- Typical operating ranges:
  - STI Device 10.5 – 210mm
  - NGSM Device 10.5 – 180mm
- The nominal ID gap is set at specified magnet poles. This means that due to magnetic tuning there may be spots along the structure that are higher by 100μm. So, in some cases the total clearence between the magnetic array and the vacuum chamber may be as tight as 25μm (0.001") to either side of the chamber.



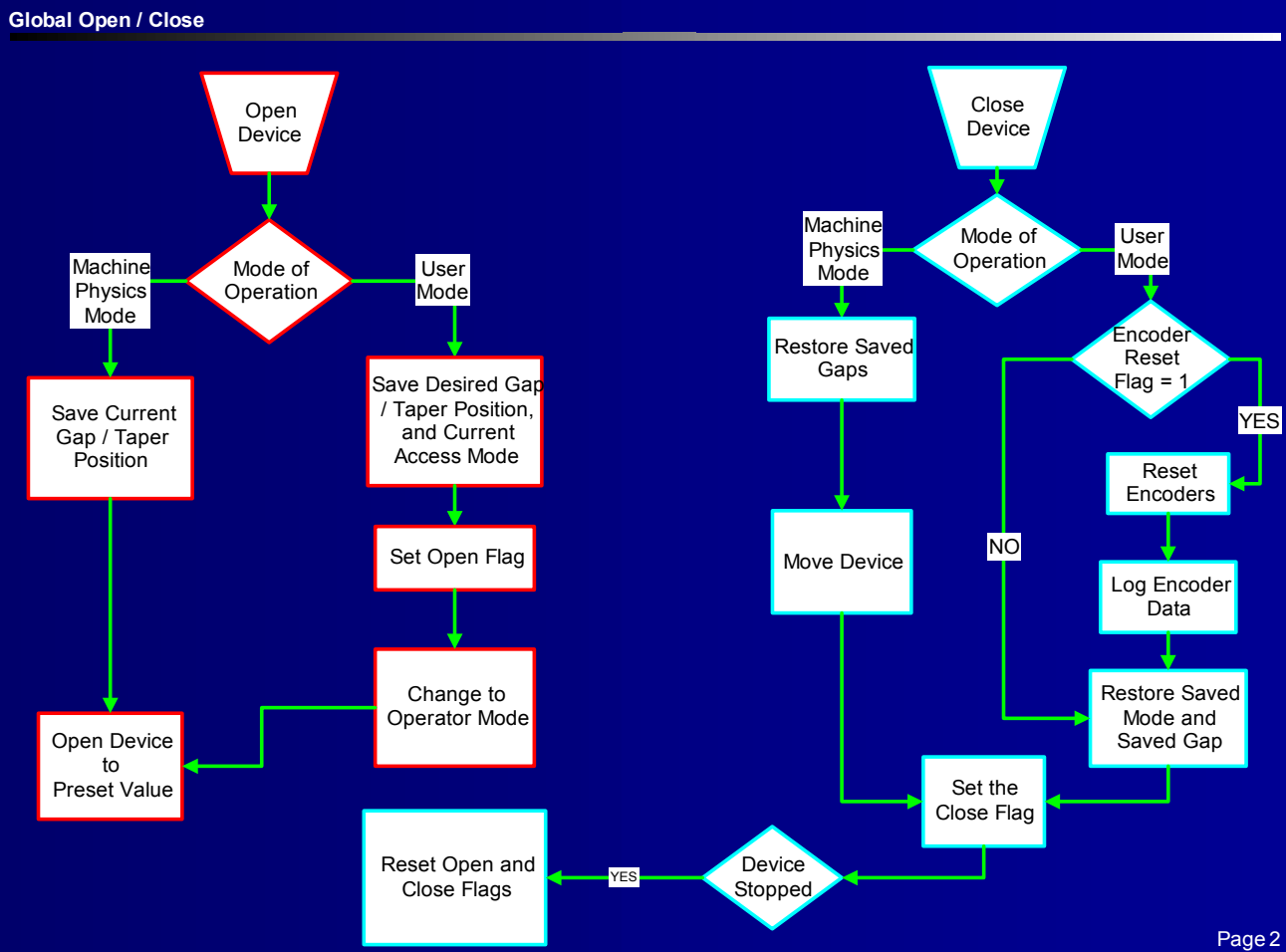
Hardware Block Diagram



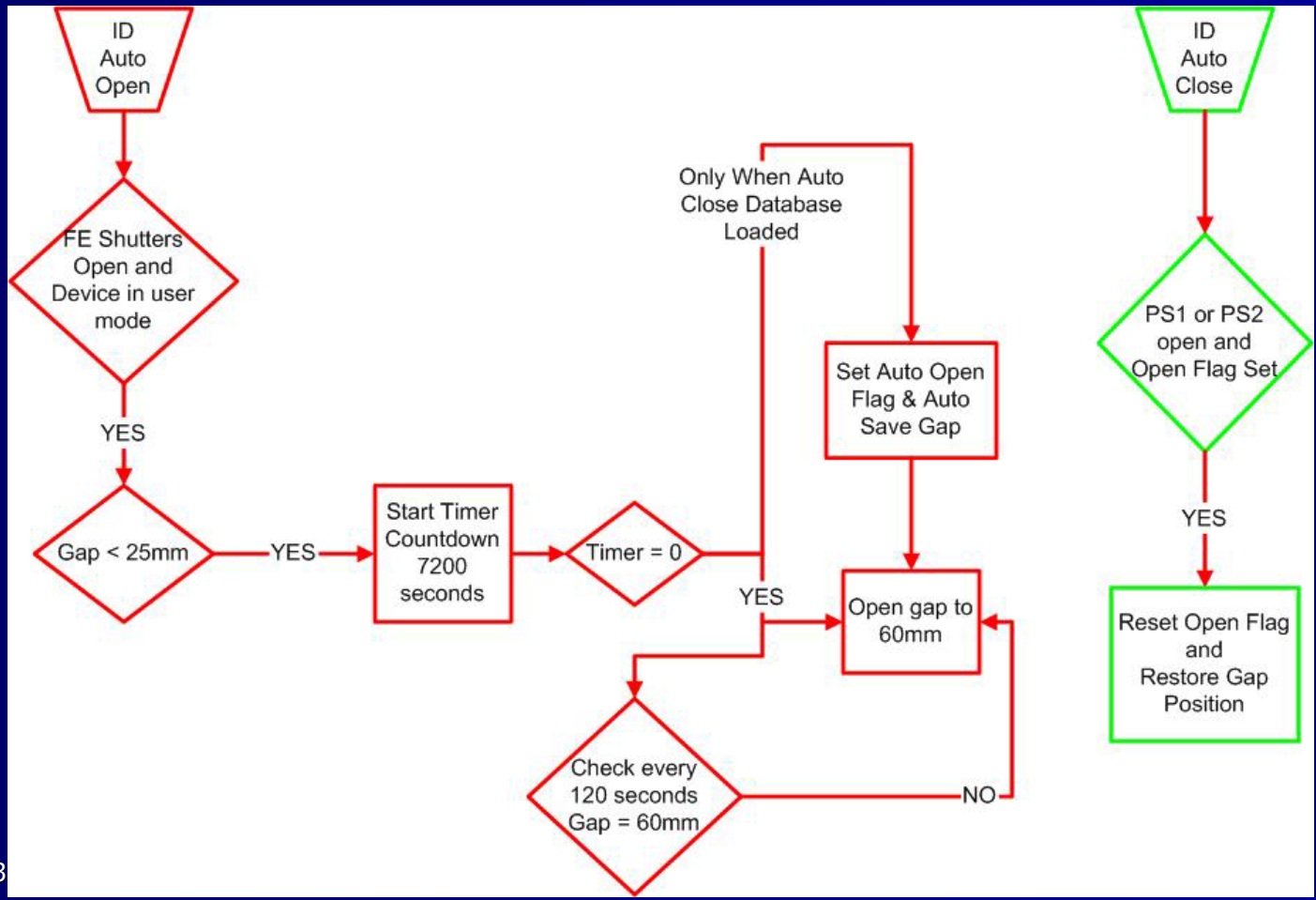
EPICS Databases



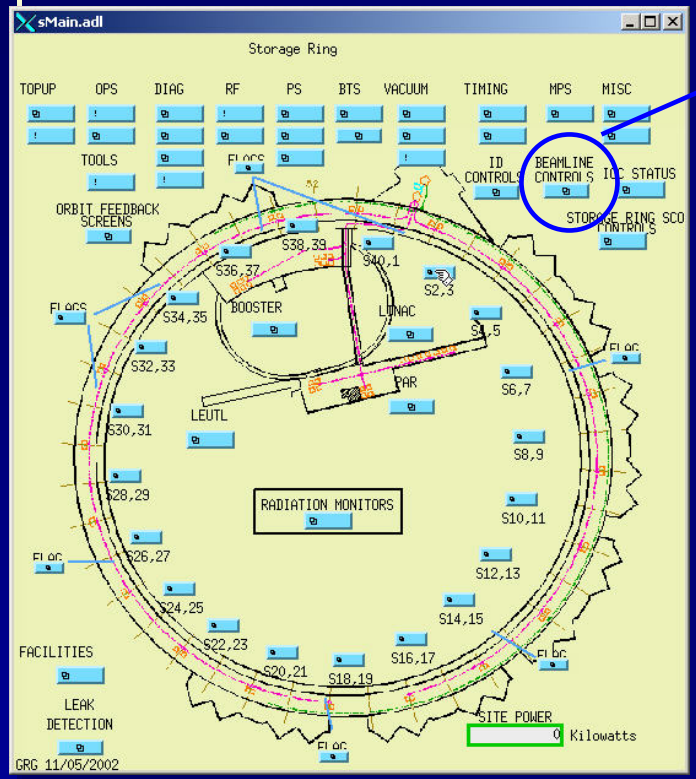
ID Global Open/Close

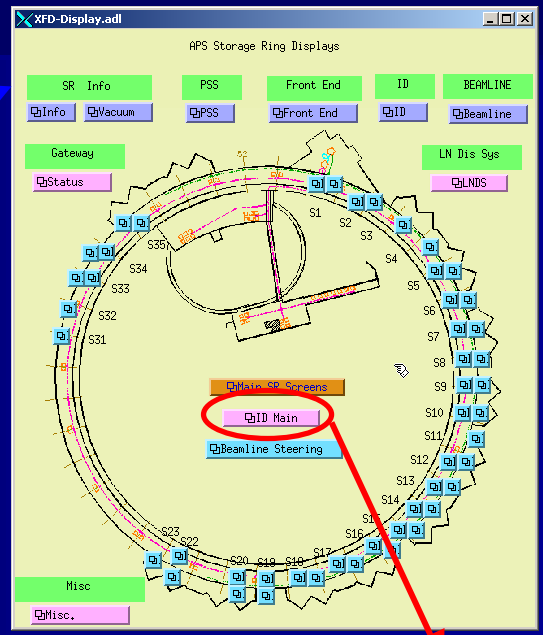


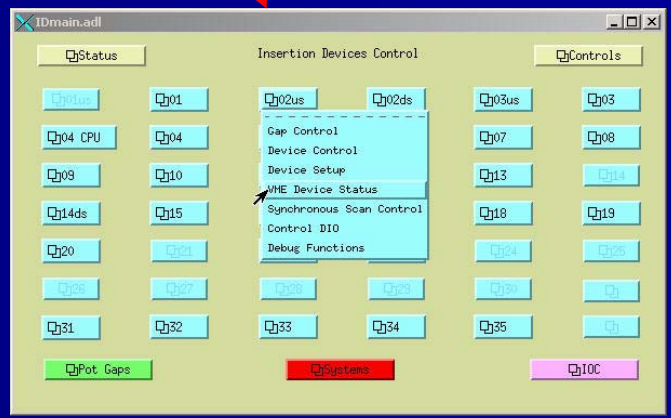
ID Auto Open/Close



Navigating Displays







ID Control Status

Desired gap/taper position.

Gap/Energy conversion status.

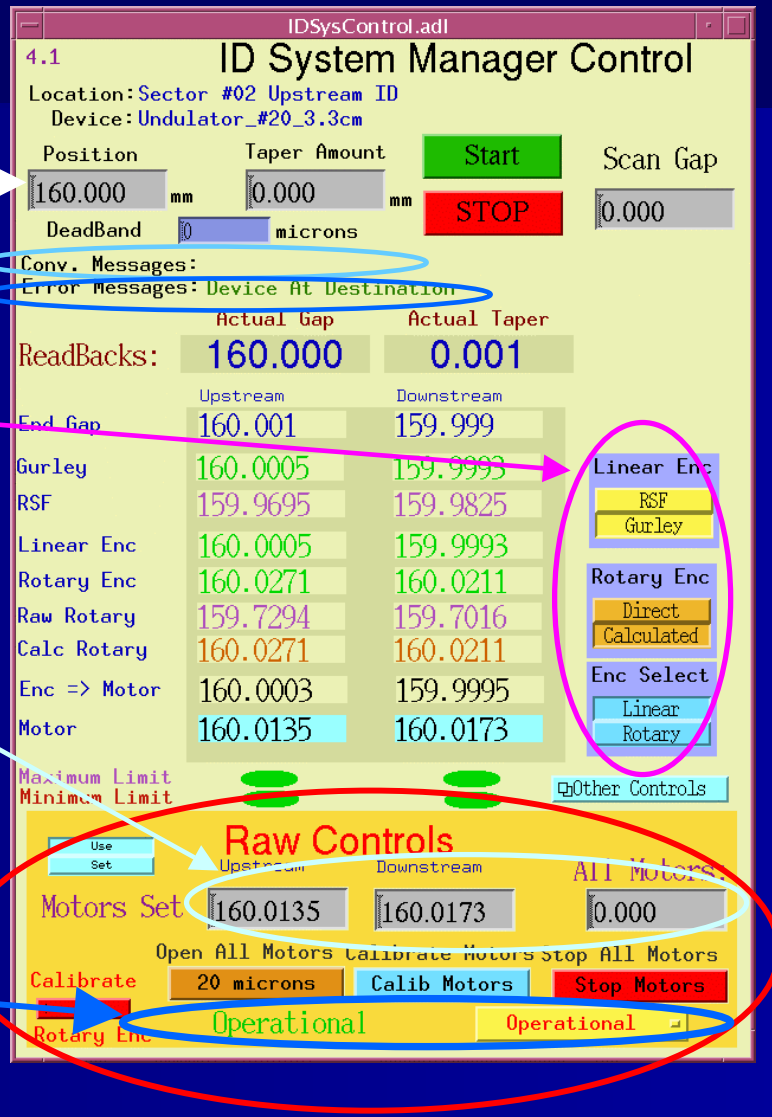
ID control messages.

Encoder selection.

Motor record VAL fields.

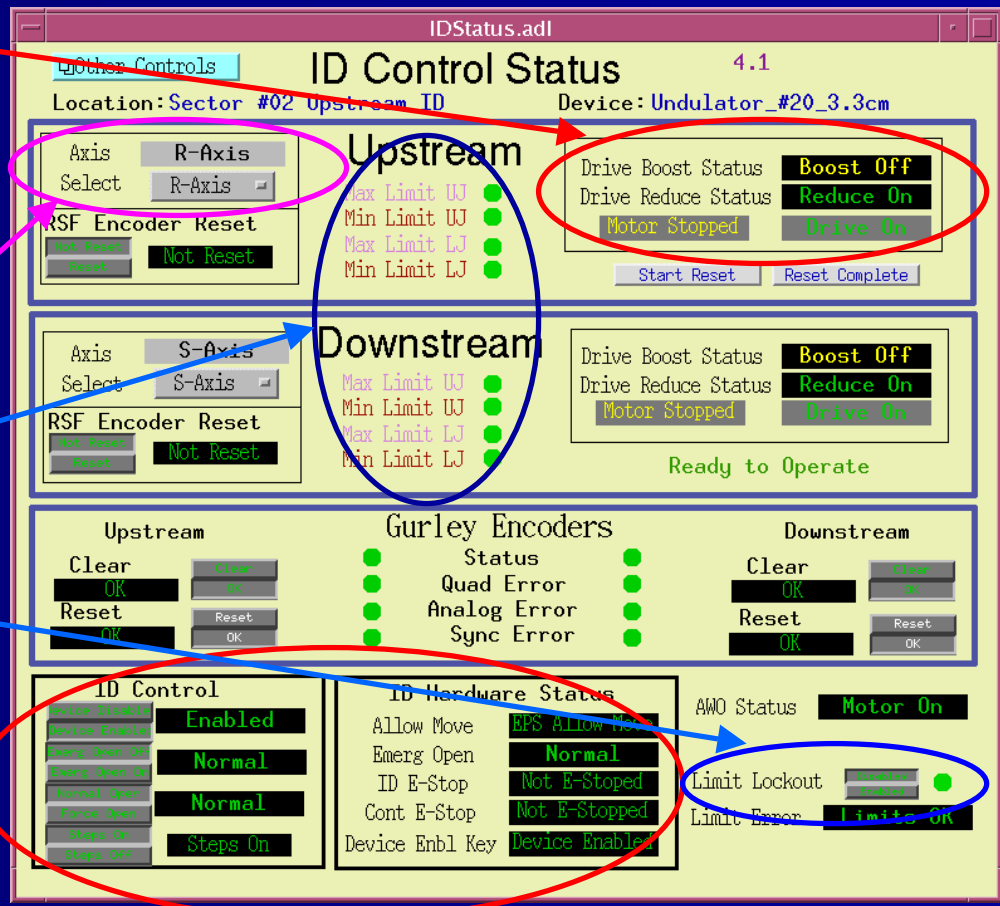
When ID is “Global Busy” movement may only be done by using the “Raw Controls”.

The ID can only be moved using the normal controls when “Operational”.



ID Control Status

- Stepper motor drive status.
- "Boost On" indicates motor controller step output is active
- Stepper motor axis selection must change motor record axis if this is changed.
- Limit switch status, which switch is being hit.
- Minimum limit switch lockout enables the device to open when hitting min. limits.
- Hardware status and motion lockout.



COMMON FAILURES

- User is unable to control the ID gap.
  - The control is in "System Manager" & "Global Busy" mode.
  - PV gateway access security needs to be changed.
  - CAT may have made network changes. If so what was changed ? Netmask, user name, machine name, etc.
- ID is in "System Manager" mode
  - The control "thinks" the ID went out of bounds.
    - Usually an encoder error (may be transient).
- Why is my ID at a gap of 60mm ?
  - The front end shutters were closed and the ID was at a gap less than 25mm for more than 2 hours. ID auto open database moved the device.
  - The AB link is down to the FE IOC and FE shutter position cannot be updated. (Last known shutter state was closed.)

More Information

- ID Control hardware information
  - http://www.aps4.anl.gov/id/idcontrol.html
- ID activity log files
  - http://www.aps4.anl.gov/user_operations/bin/IDlogs_list.pl
- PV Gateway Status
  - http://www.aps.anl.gov/aod/blops/status/pvGatewayStatus.html
- Troubleshooting Common Problems
  - asdctls\documentation\online_systems\id_fe\tutorial\Insertion Device Control System Troubleshooting.doc

ID Control System Publications

- Publications
  - VME insertion device control at the APS
    - \asdctls\documentation\online_systems\id_fe\Papers\RSI01454.pdf
  - Overview of insertion device controls at APS
    - \asdctls\documentation\online_systems\id_fe\Papers\RSI01448.pdf
  - Insertion device operating experience at the APS
    - \asdctls\documentation\online_systems\id_fe\Papers\RSI01433.pdf